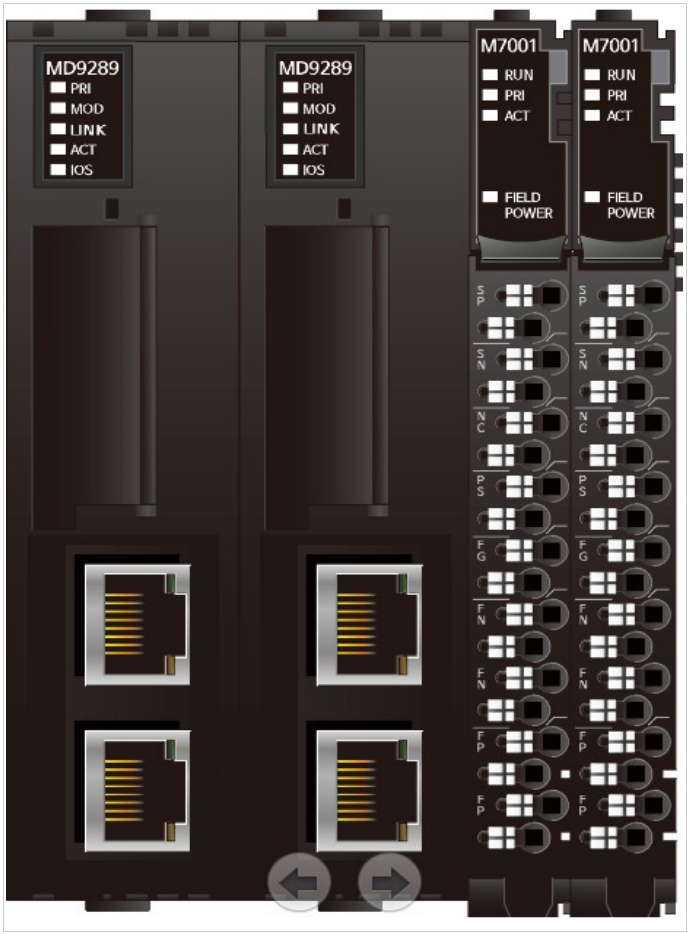
# FnIO M - Series:

# *MD9289*

## *MD9289 MODBUS TCP Network Adapter (Dual Type)*



# Table of Contents

## History

| REV. | PAGES | REMARKS | DATE | Editor |
|---|---|---|---|---|
| - | | Preliminary | 2018/6/18 | BS HA |
| 1.00 | | | 2019/03/18 | YM KIM |
| 1.01 | 5 | Image, UL Spec, Hotswap Function | 2020/04/21 | CW SEO |
| 1.02 | 5,6 | Vibration specification, Product certification changed | 2020/04/27 | CW SEO |
| 1.03 | 34.35 | Added ATEX certificate | 2020/05/07 | CW SEO |
| 1.04 | | Modify Modbus IO Firmware Address Description | 2020/10/29 | CW SEO |
| 1.05 | | Remove Description pages of Hot Swap Function, Use in Hazardous Envirnments and Caution(Before using the unit) | 2020/12/07 | SJ LIM |
| 1.06 | | Added MODBUS/TCP IP - Web Server | 2021/05/31 | BS HA |
| 1.07 | | 0x1042(4162) Register Description changed | 2021/07/09 | BS HA |
| 1.08 | 5 | Environment Specification Update | 2021/11/16 | EC KIM |
| 1.09 | 5 | Certificate Update | 2023/06/01 | CW SEO |

# 1. ENVIRONMENT SPECIFICATION

| **Environmental specification** | |
|---|---|
| Operating Temperature | -25℃~60℃ |
| UL Temperature | -25℃~60℃ |
| Storage Temperature | -40℃~85℃ |
| Relative Humidity | 5% ~ 90% non-condensing |
| Mounting | DIN rail |
| | |
| **General specification** | |
| Shock Operating | IEC 60068-2-27 |
| Vibration Resistance | IEC 60068-2-6, 4g |
| Industrial Emissions | EN 61000-6-4/A11 : 2011 |
| Industrial Immunity | EN 61000-6-2 : 2019 |
| Installation Position | Vertical and horizontal installation is available. |
| Product Certifications | UL, ATEX, CE, UKCA ,ABS, BV, CCS, DNV, KR, LR |

# 2. MD9289 (MODBUS RS485 NETWORK ADAPTER)

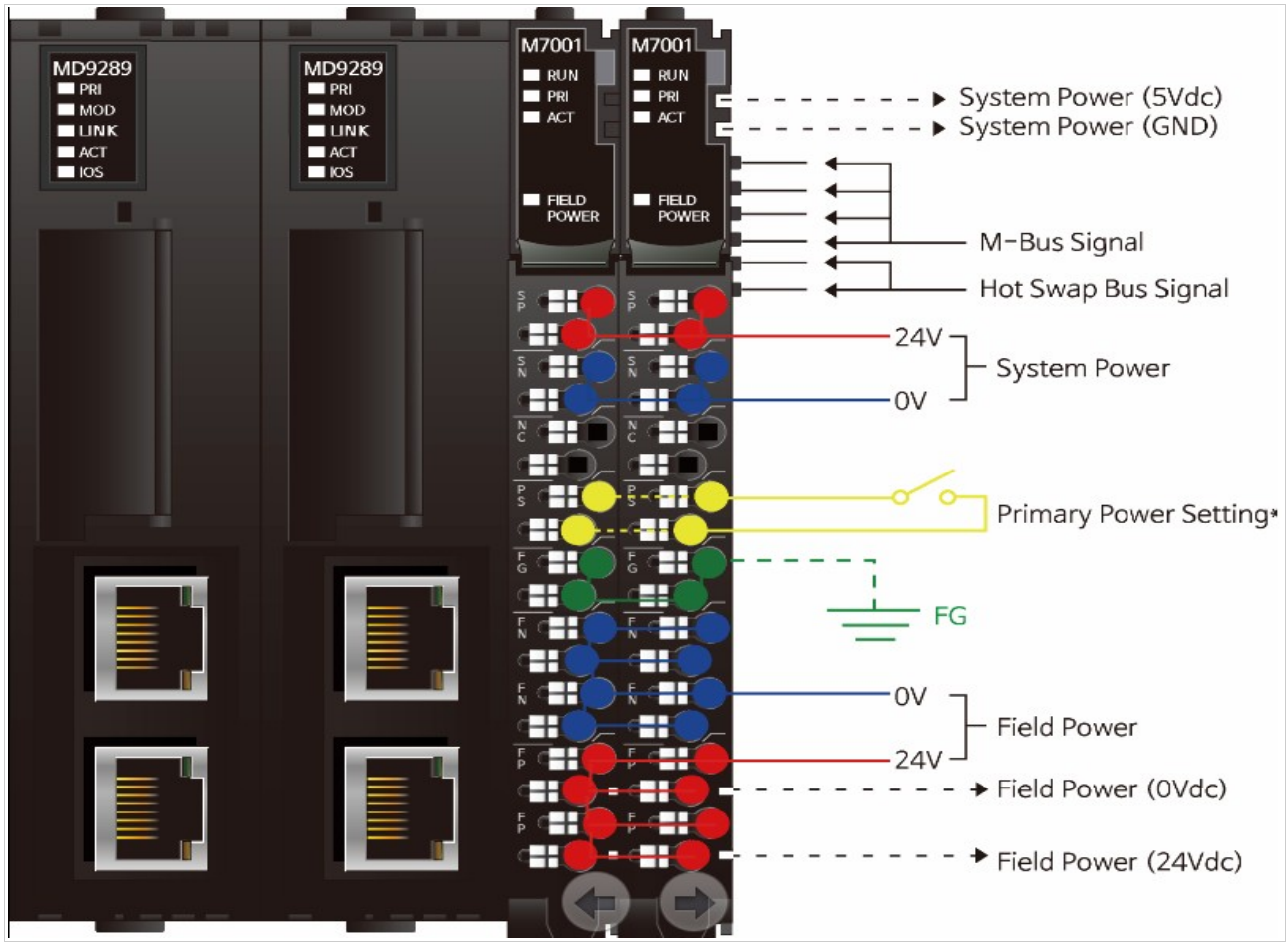
## 2.1. MD9289 Specification

| Items | Specification |
|---|---|
| **Communication Interface Specification** | |
| Adapter Type | Slave node (MODBUS/TCP,MODBUS/UDP Server), Dual |
| Protocol | MODBUS/TCP,MODBUS/UDP,HTTP,DHCP,10 TCP Connections |
| Max. Expansion Module | 63 slots |
| Max. Redundancy Data Size (Input + Output + Parameter) | Max 400 byte |
| Max. Data Size(Input + Output) | Max 128 bytes each slot |
| Max Length Bus Line | Up to 100m from Ethernet Hub/Switch with twisted CAT5 UTP/STP |
| Max. Nodes | Limited by Ethernet Specification. |
| Baud Rate | 10/100Mbps, Auto-negotiation, Full duplex |
| Interface Connector | RJ-45 socket * 2pcs |
| IP-Address Setup | Via DHCP/BOOTP or IOGuide(Crevis Software) |
| IP-Address Range | xxx.xxx.xxx.1 ~ 253 (User area) |
| Serial Port | RS232 for MODBUS/RTU, Touch Pannel or IOGuidePro |
| Serial Configuration (RS232) | Node : 1 (Fixed)<br>Baud Rate : 115200 (Fixed)<br>Data bit : 8 (Fixed)<br>Parity bit : No parity (Fixed)<br>Stop bit : 1 (Fixed) |
| Indicator | 5 LEDs<br>1 Green/Red, Main module Status (PRI)<br>1 Green/Red, Module Status (MOD)<br>1 Green, Physical Connection (LINK)<br>1 Green, Exchange Data/Traffic Present (ACT)<br>1 Green/Red, Expansion I/O Module Status (IOS)<br>2 LEDs (each RJ45 Connector)<br>1 Yellow, Link/Active<br>1 Green, Not used |
| Module Location | Starter module left side of M-Series system |
| **General specification (Supplied by M7001)** | |
| UL System Power | Supply voltage : 24Vdc nominal, Class 2 |
| System Power | Supply voltage : 24Vdc nominal<br>Supply voltage range : 15~28.8Vdc<br>Protection : Output current limit, Reverse polarity protection |
| Power Dissipation | 150mA typical @ 24Vdc |
| Current for I/O Module | 2.0A @ 5Vdc<br>(If except for NA, current for I/O module is about 1.5A) |
| Isolation | System power to internal logic : Non-isolation<br>System power I/O driver : Isolation |
| UL Field Power | Supply voltage : 24Vdc nominal, Class 2 |
| Field Power | Supply voltage : 24Vdc typical (Max. 28.8Vdc)<br>* Field Power Range is different depending on IO Module series. Refer to IO Module`s Specification. |
| Single Wire | 0.205㎟ - 1.3㎟ (24-16 AWG) |
| Torque | 0.8Nm(7 lb-in) |
| Max. Current Field Power Contact | DC 10A Max |
| Weight | 356g |

| | |
|---|---|
| Module Size | 25.7mm x 107.5mm x 56.5mm |
| Redundancy | Possible |
| **Environment Condition** | **Refer to '1. Environment Specification'** |

* Class 2, adjacent to voltage rating (30Vmax)

## 2.2. MD9289 Wiring Diagram




*** Primary Power Setting (P.S pin)**

- Short the P.S pin to set one of the two M7001 as the primary power.

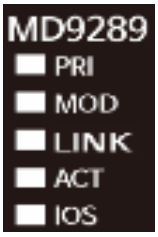
| Pin No. | | Signal Description |
|---|---|---|
| 0 | SP | System Power, 24V |
| 1 | SP | System Power, 24V |
| 2 | SN | System Power, 0V(GND) |
| 3 | SN | System Power, 0V(GND) |
| 4 | NC | ---------- |
| 5 | NC | ---------- |
| 6 | PS | Primary Power Setting |
| 7 | PS | Primary Power Setting |
| 8 | FG | F.G |
| 9 | FG | F.G |
| 10 | FN | Field Power 0V (GND) |
| 11 | FN | Field Power 0V (GND) |
| 12 | FN | Field Power 0V (GND) |
| 13 | FN | Field Power 0V (GND) |
| 14 | FP | Field Power 24V |
| 15 | FP | Field Power 24V |
| 16 | FP | Field Power 24V |
| 17 | FP | Field Power 24V |

| Series No | Through Air | Over Surface | CTI |
|---|---|---|---|
| RTB18C | 1.5mm | 1.5mm | 175≤CTI≤400 |

Spacings : The follwing minimum spcing in inches(millimeters) shall be maintained between uninsulated live parts of opposite polarity; and beween an uninsulated live part and a grounded Part including any mounting surface or exposed metal part.

## 2.3. MD9289 LED Indicator

### 2.3.1. LED Indicator




| LED No. | LED Function / Description | LED Color |
|---|---|---|
| PRI | Primary Status | Green/Red |
| MOD | Module Status | Green/Red |
| LINK | Physical Connection | Green |
| ACTIVE | Exchange Data/Traffic Present | Green |
| IOS | Extension Module Status | Green/Red |

### 2.3.2. PRI(Primary Status LED)

| Status | LED | To indicate |
|---|---|---|
| Substitution Network Adapter | OFF | Standby with Substitution network adapter. |
| Main Network Adapter | Green | When the network adapter is operating in main operation. |
| Abnormal | Flashing Green | There is no Secondary.<br>No communication response. |
| | Flashing Red | Primary is not request. |

### 2.3.3. MOD (Module Status LED)

| Status | LED | To indicate |
|---|---|---|
| Not Powered | OFF | Power is not supplied to the unit. |
| Device Operational | Green | The unit is operating in normal condition. |
| Unrecoverable Fault | Red | The device has an unrecoverable fault.<br>- Memory error or CPU watchdog error. |

### 2.3.4. LINK (Physical Connection LED)

| Status | LED | To indicate |
|---|---|---|
| Not Powered or Not Linked | OFF | Device may not be powered or not be connected |
| Adapter physical connected | Green | Adapter Ethernet Controller physically connected |

### 2.3.5. ACT (Exchange Data/Traffic Present LED)

| Status | LED | To indicate |
|---|---|---|
| Not Powered | OFF | Device is idle or may not be powered. |
| Adapter exchange data | Flashing Green | Adapter(slave) exchange data/Traffic present.<br>About 10msec flashing. |

### 2.3.6. IOS LED (Extension Module Status LED)

| Status | LED | To indicate |
|---|---|---|
| Not Powered | OFF | Device may not be powered. |
| Incorrect IO Module | Flashing Red | If Hotswap function is enable, configured module is incorrect. |
| Internal Bus Connection, Run Exchanging I/O | Green | Exchanging I/O data. |
| Expansion Configuration Failed | Red | One or more expansion module occurred in fault state.<br>- Detected invalid expansion module ID.<br>- Overflowed Input/Output Size |

| | | |
|---|---|---|
| | | - Too many expansion module<br>- Initialization failure<br>- Communication failure.<br>- Changed expansion module configuration.<br>- Mismatch vendor code between adapter and expansion module. |

## 2.4. M7001 LED Indicator

### 2.4.1. LED Indicator


| LED No. | LED Function / Description | LED Color |
|---|---|---|
| RUN | M-Bus Status | Green |
| PRI | Primary Status | Green |
| ACT | Active | Green |
| Field Power | Field Power Enable | Green |

### 2.4.2. RUN(RUN Status LED)

| Status | LED | To indicate |
|---|---|---|
| Supplied System power | Green | Supplied 5Vdc system power. |
| No System power | OFF | Not Supplied 5Vdc system power. |

### 2.4.3. PRI(Primary Status LED)

| Status | LED | To indicate |
|---|---|---|
| Primary Setting | Green | Primary power module. |
| Not Primary Setting | OFF | Secondary power module or not use redundancy function. |

### 2.4.4. ACT(Active Status LED)

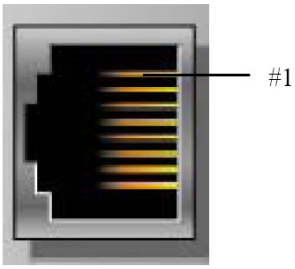
| Status | LED | To indicate |
|---|---|---|
| Main Power Module | Green | When the Power Module is operating in main operation. |
| Substitution Power Module | OFF | Standby with Substitution Power Module. |

### 2.4.5. Field Power LED (Field Power Status LED)

| Status | LED | To indicate |
|---|---|---|
| No field power | OFF | Not supplied 24Vdc field power. |
| Supplied field power | Green | Supplied 24Vdc field power. |

## 2.5. MD9289 Electrical Interface

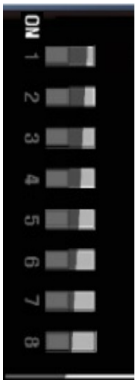
### 2.5.1. 5 Pin open connector




| RJ-45 | Signal Name | Description |
|---|---|---|
| 1 | TD+ | Transmit + |
| 2 | TD- | Transmit - |
| 3 | RD+ | Receive + |
| 4 | - | |
| 5 | - | |
| 6 | RD- | Receive - |
| 7 | - | |
| 8 | - | |
| Case | Shield | |

### 2.5.2. Dip Switch

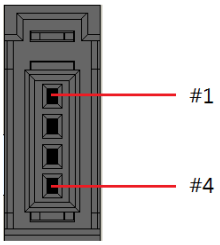
*** Set Node 1~253**




| DIP Pole# | Description |
|---|---|
| 1 | IP_DIP bit#0 |
| 2 | IP_DIP bit#1 |
| 3 | IP_DIP bit#2 |
| 4 | IP_DIP bit#3 |
| 5 | IP_DIP bit#4 |
| 6 | IP_DIP bit#5 |
| 7 | IP_DIP bit#6 |
| 8 | IP_DIP bit#7 |
| All ON | IAP function (192.168.100.100) |

* Default IP Address 192.168.100.99
* Bootp, DHCP is set by node 254

### 2.5.3. RS232 Port for MODBUS/RTU, Touch Panel or IO-Guide

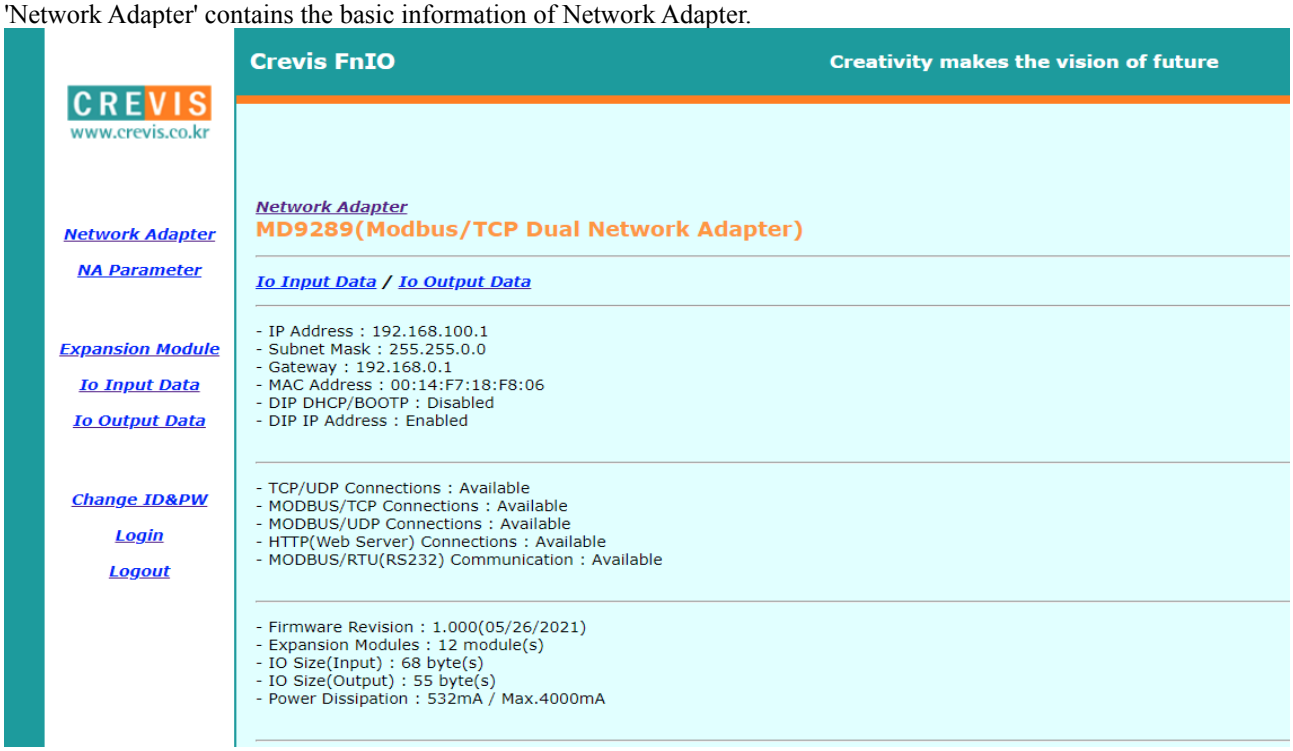



| Pin# | Signal Name | Description |
|---|---|---|
| 1 | Reserved | ---- |
| 2 | TXD | RS232 TXD |
| 3 | RXD | RS232 RXD |
| 4 | GND | RS232 GND |

## 2.6. MODBUS/TCP IP - Web Server

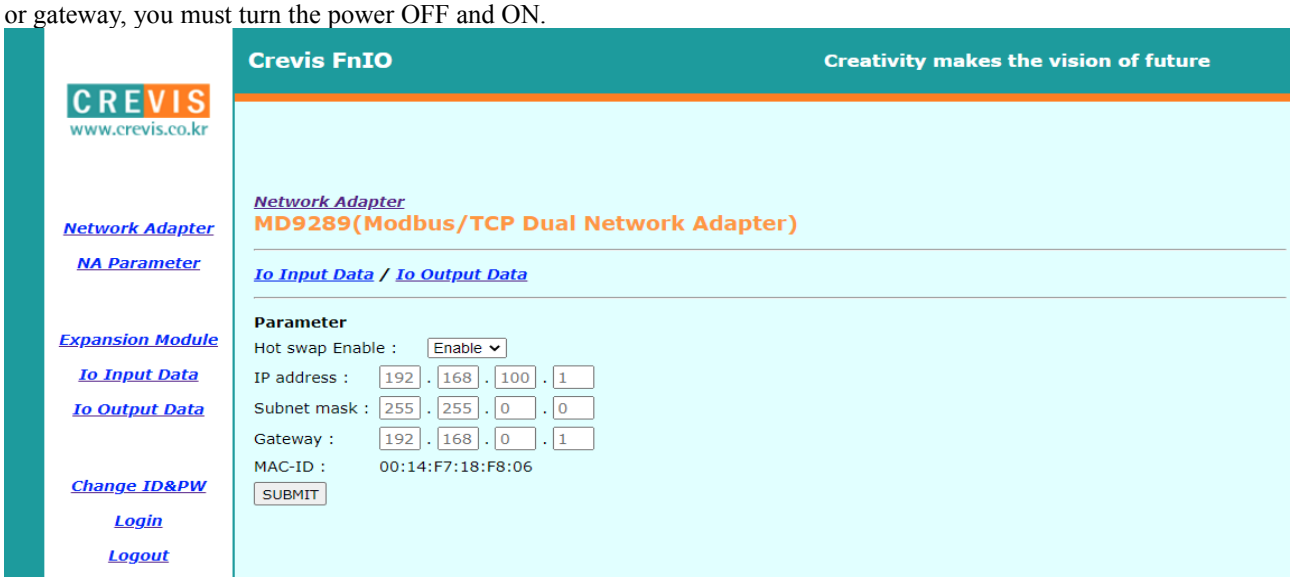
### 2.6.1. Network Adapter

'Network Adapter' contains the basic information of Network Adapter.



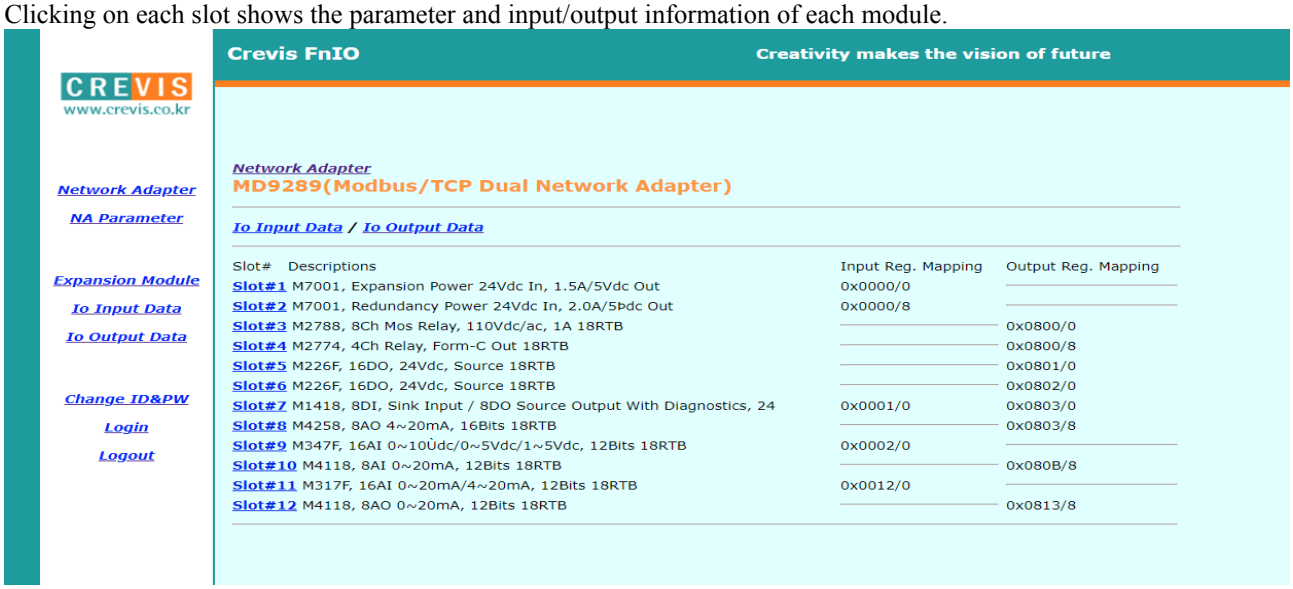

### 2.6.2. NA Parameter

Change the hotswap disable/enable and IP, subnet, gateway setting in 'NA Parameter'. When you change the IP, subnet or gateway, you must turn the power OFF and ON.



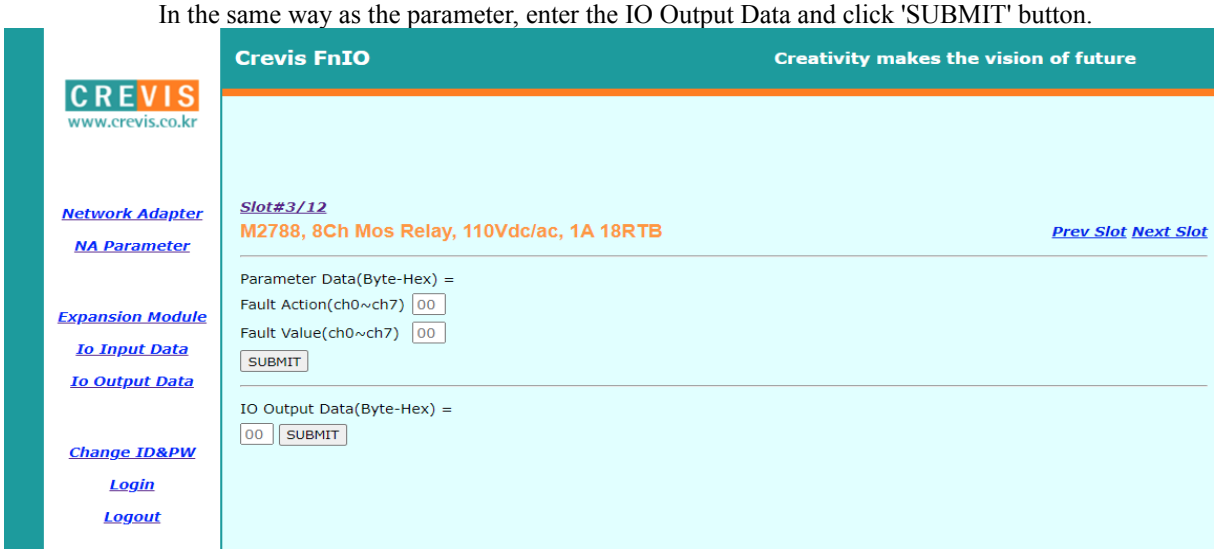
### 2.6.3. Expansion Module

'Expansion Module' shows the expansion module connected to MD9289.
Clicking on each slot shows the parameter and input/output information of each module.



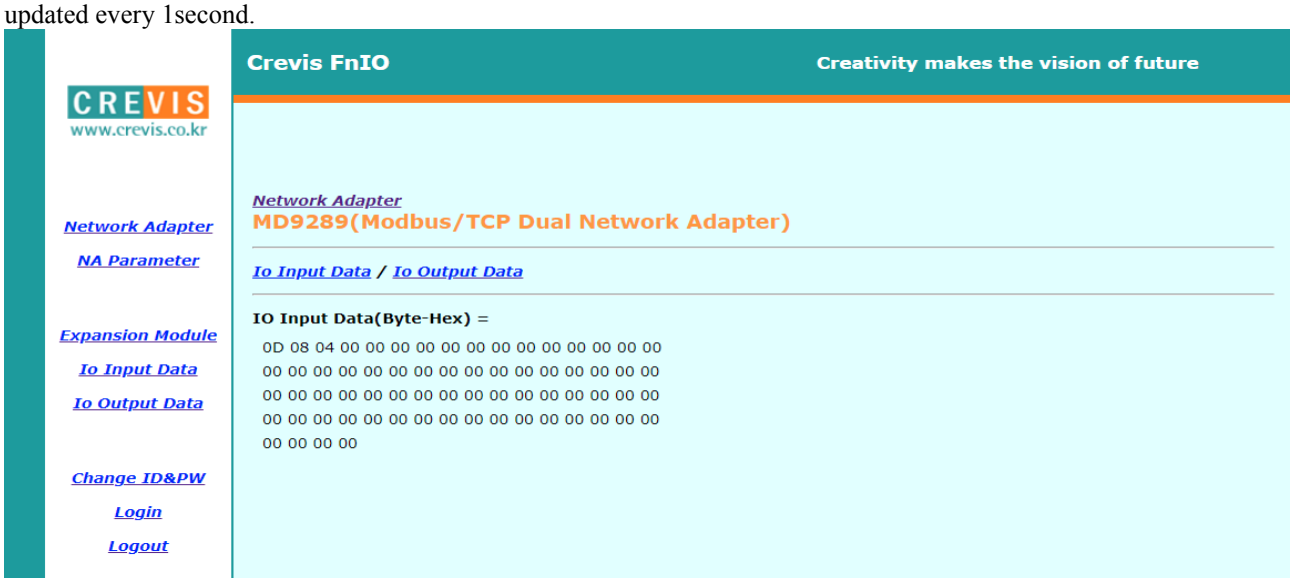

Input Module : After entering the Parameter Data, click 'SUBMIT' button to change the parameter value.
IO Input Data is automatically updated every 1second.


Output Module : After entering the Parameter Data, click 'SUBMIT' button to change the parameter value.
In the same way as the parameter, enter the IO Output Data and click 'SUBMIT' button.



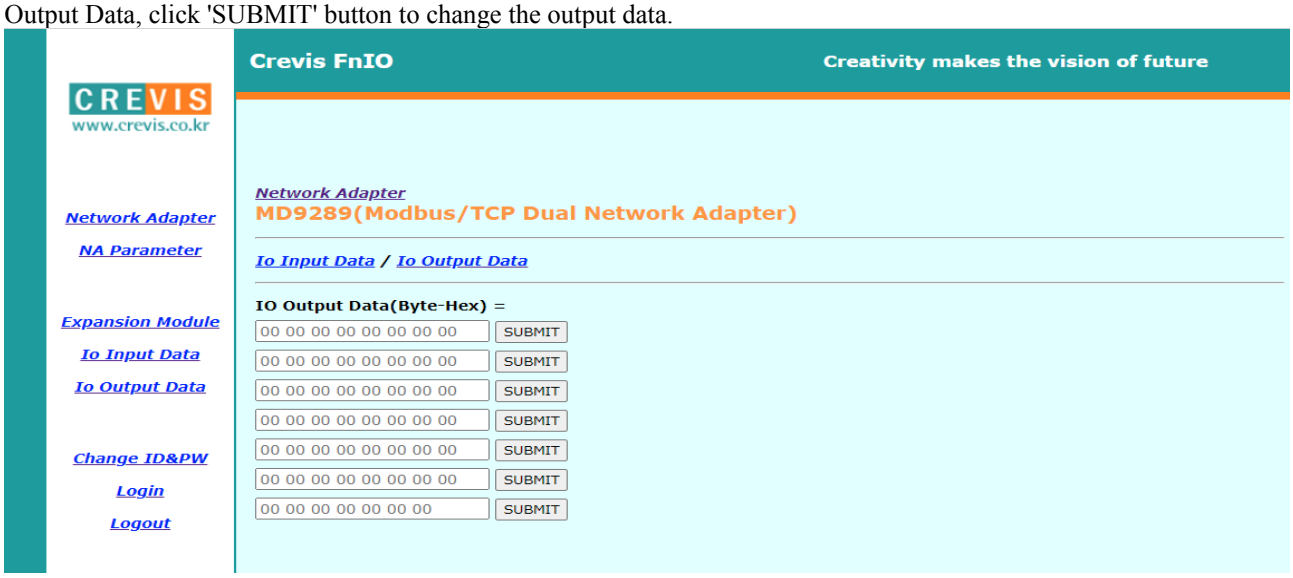
### 2.6.4. Io Input Data

In 'Io Input Data', all input data among the modules connected to MD9289 are displayed. IO Input Data is automatically updated every 1second.




### 2.6.5. Io Output Data

In 'Io Output Data', all output data among the modules connected to MD9289 are displayed. After entering the IO Output Data, click 'SUBMIT' button to change the output data.



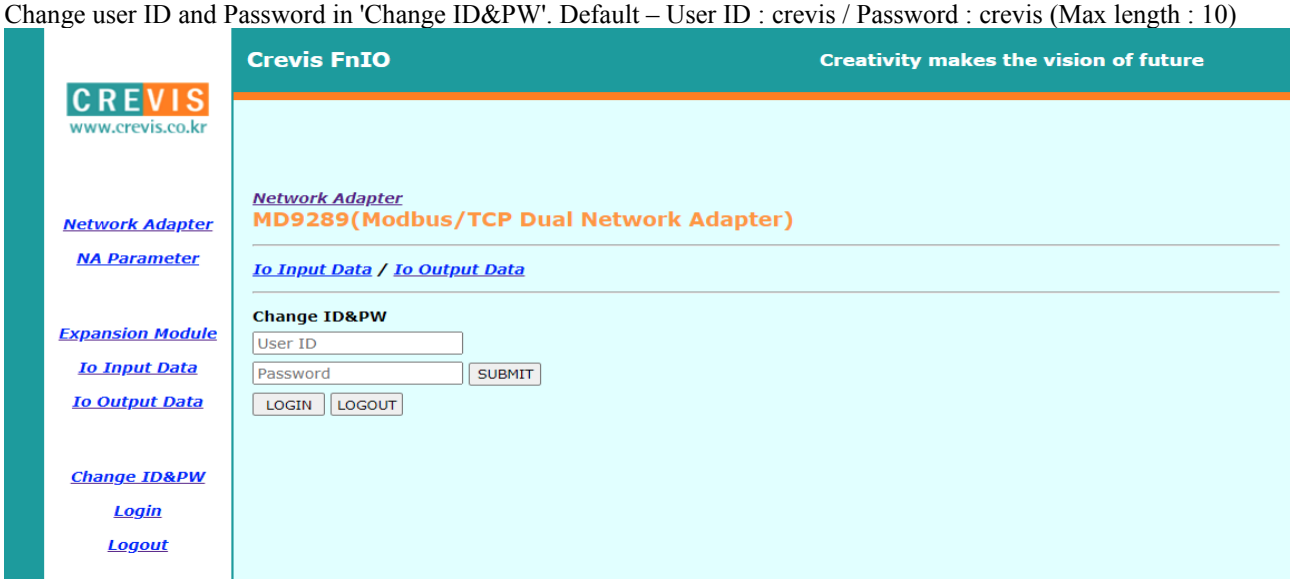

Output data is separated by spaces.
[Example]
**- For explanation, it is marked with '/' instead of space.**

| NO | Write Data | Data Type | byte0 | byte1 | byte2 | byte3 | byte4 | byte5 | byte6 | byte7 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1) | /32/F/F0 | Byte-Hex | 0xXX | 0x32 | 0x0F | 0xF0 | 0xXX | 0xXX | 0xXX | 0xXX |
| 2) | A//F5/ | Byte-Hex | 0x0A | 0xXX | 0xF5 | 0xXX | 0xXX | 0xXX | 0xXX | 0xXX |
| 3) | //14FC/A2/ | Word-Hex | 0xXX | 0xXX | 0xXX | 0xXX | 0xFC | 0x14 | 0xA2 | 0x00 |
| 4) | EC/1045//D | Word-Hex | 0xEC | 0x00 | 0x45 | 0x10 | 0xXX | 0xXX | 0x0D | 0x00 |

- No Changed : 0xXX

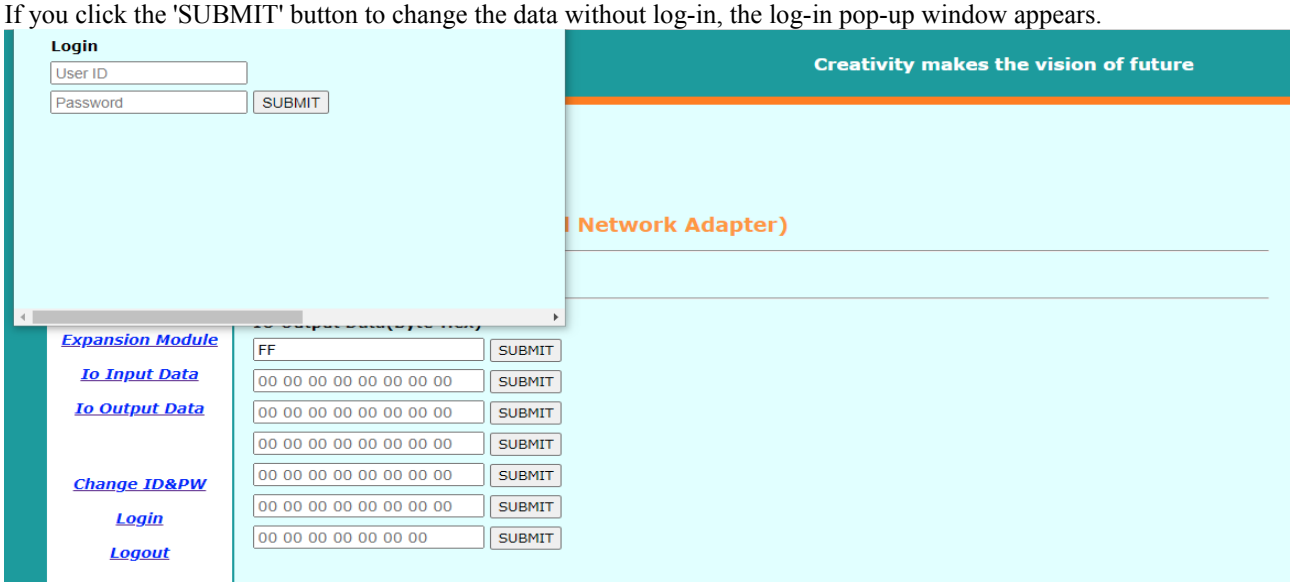
### 2.6.6. Security

Change user ID and Password in 'Change ID&PW'. Default – User ID : crevis / Password : crevis (Max length : 10)




### 2.6.7. Log-in / Log-out

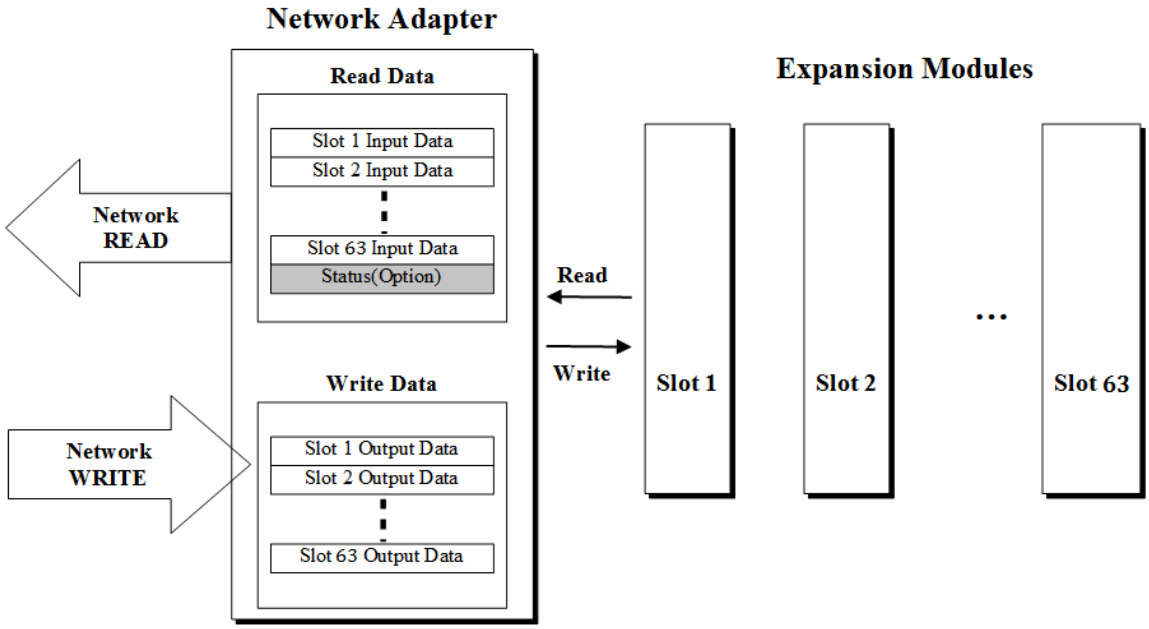
If you click the 'SUBMIT' button to change the data without log-in, the log-in pop-up window appears.




When you log-out, 'Log-out Success' pop-up appears.

## 2.7. Process Image Map

An expansion module may have 3 types of data as I/O data, configuration parameter and memory register.
The data exchange between network adapter and expansion modules is done via an I/O process image data by M-Series protocol. The following figure shows the data flow of process image between network adapter and expansion modules.




### 2.7.1. MODBUS Interface Register/Bit Map

- **Register Map**

| Start Address | Read/Write | Description | Func. Code |
|---|---|---|---|
| 0x0000 ~ | Read | Process input image registers (Real Input Register) | 3,4,23 |
| 0x0800 ~ | Read/Write | Process output image registers (Real Output Register) | 3,16,23 |
| | | | |
| 0x1000 * | Read | Adapter Identification special registers. | 3,4,23 |
| 0x1020 * | Read/Write | Adapter Watchdog, other time special register. | 3,4,6,16,23 |
| 0x1100 * | Read/Write | Adapter Information special registers. | 3,4,6,16,23 |
| 0x2000 * | Read/Write | Expansion Slot Information special registers. | 3,4,6,16,23 |

* The special register map must be accessed by read/write of each address (one address).

- **Register Map**

| Start Address | Read/Write | Description | Func. Code |
|---|---|---|---|
| 0x0000~ | Read | Process input image bits<br>All input register areas are addressable by bit address.<br>Size of input image bit is size of input image register * 16. | 2 |
| 0x1000~ | Read/Write | Process output image bits<br>All output register areas are addressable by bit address.<br>Size of output image bit is size of output image register * 16. | 1,5,15 |

## 2.7.2. Example of Input and Output Process Image Map

Input image data depends on slot position and expansion slot data type. Input process image data is only ordered by expansion slot position

- **For example slot configuration**


| Slot No. | Module Description |
|---|---|
| #0 | MODBUS/TCP Adapter |
| #1 | Power Input |
| #2 | Power Input |
| #3 | 16-discrete input |
| #4 | 16-discrete output |
| #5 | 16-analog input |
| #6 | 8-analog output |
| #7 | 8-discrete output |
| #8 | 8-discrete output |

- **Input Process Image**

| Address | b15 | b14 | b13 | b12 | b11 | b10 | b9 | b8 | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x0001 | Power Input (Slot#2) | | | | | | | | Power Input (Slot#1) | | | | | | | |
| 0x0002 | Discrete Input 16 pts (Slot#3) | | | | | | | | | | | | | | | |
| 0x0003 | Analog Input Ch0 high byte (Slot#5) | | | | | | | | Analog Input Ch0 low byte (Slot#5) | | | | | | | |
| 0x0004 | Analog Input Ch1 high byte (Slot#5) | | | | | | | | Analog Input Ch1 low byte (Slot#5) | | | | | | | |
| 0x0005 | Analog Input Ch2 high byte (Slot#5) | | | | | | | | Analog Input Ch2 low byte (Slot#5) | | | | | | | |
| 0x0006 | Analog Input Ch3 high byte (Slot#5) | | | | | | | | Analog Input Ch3 low byte (Slot#5) | | | | | | | |
| 0x0007 | Analog Input Ch4 high byte (Slot#5) | | | | | | | | Analog Input Ch4 low byte (Slot#5) | | | | | | | |
| 0x0008 | Analog Input Ch5 high byte (Slot#5) | | | | | | | | Analog Input Ch5 low byte (Slot#5) | | | | | | | |
| 0x0009 | Analog Input Ch6 high byte (Slot#5) | | | | | | | | Analog Input Ch6 low byte (Slot#5) | | | | | | | |
| 0x000A | Analog Input Ch7 high byte (Slot#5) | | | | | | | | Analog Input Ch7 low byte (Slot#5) | | | | | | | |
| 0x000B | Analog Input Ch8 high byte (Slot#5) | | | | | | | | Analog Input Ch8 low byte (Slot#5) | | | | | | | |
| 0x000C | Analog Input Ch9 high byte (Slot#5) | | | | | | | | Analog Input Ch9 low byte (Slot#5) | | | | | | | |
| 0x000D | Analog Input Ch10 high byte (Slot#5) | | | | | | | | Analog Input Ch10 low byte (Slot#5) | | | | | | | |
| 0x000E | Analog Input Ch11 high byte (Slot#5) | | | | | | | | Analog Input Ch11 low byte (Slot#5) | | | | | | | |
| 0x000F | Analog Input Ch12 high byte (Slot#5) | | | | | | | | Analog Input Ch12 low byte (Slot#5) | | | | | | | |
| 0x0010 | Analog Input Ch13 high byte (Slot#5) | | | | | | | | Analog Input Ch13 low byte (Slot#5) | | | | | | | |
| 0x0011 | Analog Input Ch14 high byte (Slot#5) | | | | | | | | Analog Input Ch14 low byte (Slot#5) | | | | | | | |
| 0x0012 | Analog Input Ch15 high byte (Slot#5) | | | | | | | | Analog Input Ch15 low byte (Slot#5) | | | | | | | |

- **Output Process Image**

| Address | b15 | b14 | b13 | b12 | b11 | b10 | b9 | b8 | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0x0800 | Discrete Output 16 pts (Slot#4) | | | | | | | | | | | | | | | |
| 0x0801 | Analog Output Ch0 high byte (Slot#6) | | | | | | | | Analog Output Ch0 low byte (Slot#6) | | | | | | | |
| 0x0802 | Analog Output Ch1 high byte (Slot#6) | | | | | | | | Analog Output Ch1 low byte (Slot#6) | | | | | | | |
| 0x0803 | Analog Output Ch2 high byte (Slot#6) | | | | | | | | Analog Output Ch2 low byte (Slot#6) | | | | | | | |
| 0x0804 | Analog Output Ch3 high byte (Slot#6) | | | | | | | | Analog Output Ch3 low byte (Slot#6) | | | | | | | |
| 0x0805 | Analog Output Ch4 high byte (Slot#6) | | | | | | | | Analog Output Ch4 low byte (Slot#6) | | | | | | | |
| 0x0806 | Analog Output Ch5 high byte (Slot#6) | | | | | | | | Analog Output Ch5 low byte (Slot#6) | | | | | | | |
| 0x0807 | Analog Output Ch6 high byte (Slot#6) | | | | | | | | Analog Output Ch6 low byte (Slot#6) | | | | | | | |
| 0x0808 | Analog Output Ch7 high byte (Slot#6) | | | | | | | | Analog Output Ch7 low byte (Slot#6) | | | | | | | |
| 0x0809 | Discrete Output 8 pts (Slot#8) | | | | | | | | Discrete Output 8 pts (Slot#7) | | | | | | | |

# 3. MODBUS INTERFACE

## 3.1. MODBUS Interface Register/Bit Map

- **Register Map**

| Start Address | Read/Write | Description | Func. Code |
|---|---|---|---|
| 0x0000 ~ | Read | Process input image registers (Real Input Register) | 3,4,23 |
| 0x0800 ~ | Read/Write | Process output image registers (Real Output Register) | 3,16,23 |
| | | | |
| 0x1000 * | Read | Adapter Identification special registers. | 3,4,23 |
| 0x1020 * | Read/Write | Adapter Watchdog, other time special register. | 3,4,6,16,23 |
| 0x1100 * | Read/Write | Adapter Information special registers. | 3,4,6,16,23 |
| 0x2000 * | Read/Write | Expansion Slot Information special registers. | 3,4,6,16,23 |

* The special register map must be accessed by read/write of each address (one address).

- **Register Map**

| Start Address | Read/Write | Description | Func. Code |
|---|---|---|---|
| 0x0000~ | Read | Process input image bits<br>All input register areas are addressable by bit address.<br>Size of input image bit is size of input image register * 16. | 2 |
| 0x1000~ | Read/Write | Process output image bits<br>All output register areas are addressable by bit address.<br>Size of output image bit is size of output image register * 16. | 1,5,15 |

## 3.2. Supported MODBUS Function Codes

| Function Code | Function | Description |
|---|---|---|
| 1(0x01) | Read Coils | Read output bit |
| 2(0x02) | Read Discrete Inputs | Read input bit |
| 3(0x03) | Read Holding Registers | Read output word |
| 4(0x04) | Read Input Registers | Read input word |
| 5(0x05) | Write Single Coil | Write one bit output |
| 6(0x06) | Write Single Register | Write one word output |
| 8(0x08) | Diagnostics | Read diagnostic register |
| 15(0x0F) | Write Multiple Coils | Write a number of output bits |
| 16(0x10) | Write Multiple registers | Write a number of output words |
| 23(0x17) | Read/Write Multiple registers | Read a number of input words /Write a number of output words |

- Refer to MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1a

## 3.3. MODBUS Transmission Mode

Two different serial transmission modes are defined : The RTU mode and the ASCII mode. It defines the bit contents of message fields transmitted serially on the line. It determines how information is packed into the message fields and decoded.

### 3.3.1. RTU Transmission Mode

When devices communicate on a MODBUS serial line using the RTU (Remote Terminal Unit) mode, each 8–bit byte in a message contains two 4–bit hexadecimal characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII mode for the same baud rate. Each message must be transmitted in a continuous stream of characters.

| Start | Address | Function | Data | CRC Check | End |
|---|---|---|---|---|---|
| ≥ 3.5 char | 1 char | 1 char | Up to 252 chars(s) | 2 chars | ≥ 3.5 char |

### 3.3.2. ASCII Transmission Mode

When devices are setup to communicate on a MODBUS serial line using ASCII (American Standard Code for Information Interchange) mode, each 8–bit byte in a message is sent as two ASCII characters. This mode is used when the physical communication link or the capabilities of the device does not allow the conformance with RTU mode requirements regarding timers management.

| Start | Address | Function | Data | LRC Check | End |
|---|---|---|---|---|---|
| 1 char<br>‘:’ | 2 chars | 2 chars | Up to 2x252 char(s) | 2 chars | 2 chars<br>CR,LF |

### 3.3.3. 1 (0x01) Read Coils

This function code is used to read from 1 to 2000 contiguous status of coils in a remote device. The Request PDU specifies the starting address, i.e. the address of the first coil specified, and the number of coils. In the PDU Coils are addressed starting at zero. Therefore coils numbered 1-16 are addressed as 0-15. The coils in the response message are packed as one coil per bit of the data field. Status is indicated as 1= ON and 0= OFF.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | - | t1-t2-t3 | “:” | 0x3A |
| Slave Address | 0x63 | 0x63 | “63” | 0x36, 0x33 |
| Function Code | 0x01 | 0x01 | “01” | 0x30, 0x31 |
| Starting Address Hi | 0x10 | 0x10 | “10” | 0x31, 0x30 |
| Starting Address Lo | 0x00 | 0x00 | “00” | 0x30, 0x30 |
| Quantity of Outputs Hi | 0x00 | 0x00 | “00” | 0x30, 0x30 |
| Quantity of Outputs Lo | 0x10 | 0x10 | “10” | 0x31, 0x30 |
| Error Check (CRC/LRC) | - | 0x31, 0x44 | “7C” | 0x37, 0x43 |
| End of Frame | - | t1-t2-t3 | CR, LF | 0x0D, 0x0A |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | “:” | 0x3A |
| Slave Address | 0x63 | 0x63 | “63” | 0x36, 0x33 |
| Function Code | 0x01 | 0x01 | “01” | 0x30, 0x31 |
| Byte Count | 0x02 | 0x02 | “02” | 0x30, 0x32 |
| Output Status | 0x00 | 0x00 | “00” | 0x30, 0x30 |
| Output Status | 0x00 | 0x00 | “00” | 0x30, 0x30 |
| Error Check (CRC/LRC) | --- | 0x40, 0x34 | “9A” | 0x39, 0x41 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0x0A |

### 3.3.4. 2 (0x02) Read Discrete Inputs

This function code is used to read from 1 to 2000 contiguous status of discrete inputs in a remote device. The Request PDU specifies the starting address, i.e. the address of the first input specified, and the number of inputs. In the PDU Discrete Inputs are addressed starting at zero. Therefore Discrete inputs numbered 1-16 are addressed as 0-15.
The discrete inputs in the response message are packed as one input per bit of the data field.
Status is indicated as 1= ON; 0= OFF.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "07" | 0x36, 0x33 |
| Function Code | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Starting Address Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Inputs Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Inputs Lo | 0x10 | 0x10 | "0A" | 0x31, 0x30 |
| Error Check (CRC/LRC) | --- | 0x71, 0x84 | "ED" | 0x38, 0x42 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Byte Count | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Input Status | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Input Status | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Error Check (CRC/LRC) | --- | 0x40, 0x70 | "99" | 0x39, 0x39 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

### 3.3.5. 3 (0x03) Read Holding Registers

This function code is used to read the contents of a contiguous block of holding registers in a remote device. The Request PDU specifies the starting register address and the number of registers.
The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x03 | 0x03 | "03" | 0x30, 0x33 |
| Starting Address Hi | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Register Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Register Lo | 0x01 | 0x01 | "01" | 0x30, 0x31 |
| Error Check (CRC/LRC) | --- | 0x88, 0x88 | "89" | 0x38, 0x39 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0x0A |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x03 | 0x03 | "03" | 0x30, 0x33 |
| Byte Count | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Output Register#0 Hi | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Output Register#0 Lo | 0xE5 | 0xE5 | "E5" | 0x45, 0x35 |
| Error Check (CRC/LRC) | --- | 0x81, 0x67 | "B1" | 0x42, 0x31 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0x0A |

- In case of address 0x0800, 0x0801 output register value: 0x1122, 0x3344.

### 3.3.6. 4 (0x04) Read Input Registers

This function code is used to read from 1 to approx. 125 contiguous input registers in a remote device. The Request PDU specifies the starting register address and the number of registers. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x04 | 0x04 | "04" | 0x30, 0x34 |
| Starting Address Hi | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Register Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Register Lo | 0x01 | 0x01 | "01" | 0x30, 0x31 |
| Error Check (CRC/LRC) | --- | 0x3D, 0x48 | "88" | 0x38, 0x38 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0x0A |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x04 | 0x04 | "04" | 0x30, 0x34 |
| Byte Count | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Input Register#0 Hi | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Input Register#0 Lo | 0xE5 | 0xE5 | "E5" | 0x45, 0x35 |
| Error Check (CRC/LRC) | --- | 0x80, 0x13 | "B0" | 0x42, 0x30 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- In case of address 0x0000, 0x0001 input register value: 0x0080, 0x0000.

### 3.3.7. 5 (0x05) Write Single Coil

This function code is used to write a single output to either ON or OFF in a remote device. The requested ON/OFF state is specified by a constant in the request data field. A value of FF 00 hex requests the output to be ON. A value of 00 00 requests it to be OFF. All other values are illegal and will not affect the output.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "36" | 0x36, 0x33 |
| Function Code | 0x05 | 0x05 | "05" | 0x30, 0x35 |
| Output Address Hi | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Output Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Output Value Hi | 0xFF | 0xFF | "FF" | 0x46, 0x46 |
| Output Value Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Error Check (CRC/LRC) | --- | 0x80, 0xB8 | "8Y" | 0x38, 0x59 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "36" | 0x36, 0x33 |
| Function Code | 0x05 | 0x05 | "05" | 0x30, 0x35 |
| Output Address Hi | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Output Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Output Value Hi | 0xFF | 0xFF | "FF" | 0x46, 0x46 |
| Output Value Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Error Check (CRC/LRC) | --- | 0x80, 0xB8 | "8Y" | 0x38, 0x59 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- Output bit of address 0x1001 turns ON.

### 3.3.8. 6 (0x06) Write Single Register

This function code is used to write a single holding register in a remote device. Therefore register numbered 1 is addressed as 0. The normal response is an echo of the request, returned after the register contents have been written.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x06 | 0x06 | "06" | 0x30, 0x36 |
| Register Address Hi | 0x08 | 0x08 | "08" | 0x30, 0x38 |
| Register Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Register Value Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Register Value Lo | 0xFF | 0xFF | "FF" | 0x46, 0x46 |
| Error Check (CRC/LRC) | --- | 0xC3, 0xA8 | "90" | 0x39, 0x30 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x06 | 0x06 | "06" | 0x30, 0x36 |
| Register Address Hi | 0x08 | 0x08 | "08" | 0x30, 0x38 |
| Register Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Register Value Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Register Value Lo | 0xFF | 0xFF | "FF" | 0x46, 0x46 |
| Error Check (CRC/LRC) | --- | 0xC3, 0xA8 | "90" | 0x39, 0x30 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- In case of address 0x0800 output register value: 0x0000 changes to 0x1122.

### 3.3.9. 8 (0x08) Diagnostics

MODBUS function code 08 provides a series of tests for checking the communication system between a client ( Master) device and a server ( Slave), or for checking various internal error conditions within a server.
The function uses a two–byte sub-function code field in the query to define the type of test to be performed. The server echoes both the function code and sub-function code in a normal response. Some of the diagnostics cause data to be returned from the remote device in the data field of a normal response.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x07 | 0x07 | "07" | 0x30, 0x37 |
| Function Code | 0x08 | 0x08 | "08" | 0x30, 0x38 |
| Sub-Function Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Sub-Function Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Data Hi | 0x11 | 0x11 | "11" | 0x31, 0x31 |
| Data Lo | 0x22 | 0x22 | "22" | 0x32, 0x32 |
| Error Check (CRC/LRC) | --- | 0x6C, 0x24 | "BE" | 0x42, 0x45 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x07 | 0x07 | "07" | 0x30, 0x37 |
| Function Code | 0x08 | 0x08 | "08" | 0x30, 0x38 |
| Sub-Function Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Sub-Function Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Data Hi | 0x11 | 0x11 | "11" | 0x31, 0x31 |
| Data Lo | 0x22 | 0x22 | "22" | 0x32, 0x32 |
| Error Check (CRC/LRC) | --- | 0x6C, 0x24 | "BE" | 0x42, 0x45 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

**Sub-function 0x0000(0) Return Query Data**
The data passed in the request data field is to be returned (looped back) in the response.
The entire response message should be identical to the request.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x0000(0) | Any | Echo Request Data | |

**Sub-function 0x0001(1) Restart Communications Option**
The remote device could be initialized and restarted, and all of its communications event counters are cleared.
Especially, data field 0x55AA make the remote device to restart with factory default setup of EEPROM.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x0001(1) | 0x0000 or 0xFF00 | Echo Request Data | Reset |
| 0x0001(1) | 0x55AA+0xAB7B+Sumcheck | Echo Request Data | Reset with Factory default 1) |
| 0x0001(1) | 0x55AA+0xAA55+Sumcheck | Echo Request Data | Reset with Factory default 2) |

1) Watchdog time value, auto recovery will be the factory defaults value.
2) Mac Address, IP Address, Subnet Mask Address, Gateway Address will be the factory default value.

**Sub-function 0x000A(10) Clear Counters and Diagnostic Register**
The goal is to clear all counters and the diagnostic register. Counters are also cleared upon power–up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x000A(10) | 0x0000 | Echo Request Data | |

**Sub-function 0x000B(11) Return Bus Message Count**
The response data field returns the quantity of messages that the remote device has detected on the communications system since its last restart, clear counters operation, or power–up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x000B(11) | 0x0000 | Total Message Count | |

**Sub-function 0x000C(12) Return Bus Communication Error Count**
The response data field returns the quantity of CRC errors encountered by the remote device since its last restart, clear counters operation, or power–up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x000C(12) | 0x0000 | CRC Error Count | |

**Sub-function 0x000D(13) Return Bus Exception Error Count**
The response data field returns the quantity of MODBUS exception responses returned by the remote device since its last restart, clear counters operation, or power–up.
Exception responses are described and listed in section 3.2.11.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x000D(13) | 0x0000 | Exception Error Count | |

**Sub-function 0x000E(14) Return Slave Message Count**
The response data field returns the quantity of messages addressed to the remote device, or broadcast, that the remote device has processed since its last restart, clear counters operation, or power–up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x000E(14) | 0x0000 | Slave Message Count | |

**Sub-function 0x000F(15) Return Slave No Response Count**
The response data field returns the quantity of messages addressed to the remote device for which it has returned no response (neither a normal response nor an exception response), since its last restart, clear counters operation, or power–up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x000F(15) | 0x0000 | Slave No Response Count | |

**Sub-function 0x0064(100) Return Slave ModBus, Internal Bus Status**

The response data field returns the status of ModBus and Internal Bus addressed to the remote device.
This status values are identical with status 1word of input process image.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x0064(100) | 0x0000 | ModBus, Internal Bus Status | Same as status 1word |

**Sub-function 0x0065(101) Return Slave Watchdog Error Count**

The response data field returns the quantity of watchdog error addressed to the remote device since its last restart, clear counters operation, or power–up.

| Sub-function | Data Field (Request) | Data Field (Response) | Description |
|---|---|---|---|
| 0x0065(101) | 0x0000 | Watchdog Error Count | |

### 3.3.10. 15 (0x0F) Write Multiple Coils

This function code is used to force each coil in a sequence of coils to either ON or OFF in a remote device. The Request PDU specifies the coil references to be forced. Coils are addressed starting at zero. A logical '1' in a bit position of the field requests the corresponding output to be ON. A logical '0' requests it to be OFF.
The normal response returns the function code, starting address, and quantity of coils forced.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x0F | 0x0F | "0F" | 0x30, 0x46 |
| Starting Address Hi | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Outputs Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Outputs Lo | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Byte Count | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Output Value#0 | 0x0F | 0x0F | "0F" | 0x30, 0x46 |
| Output Value#1 | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Error Check (CRC/LRC) | --- | 0x47, 0x73 | "5D" | 0x35, 0x44 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x0F | 0x0F | "0F" | 0x30, 0x46 |
| Starting Address Hi | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Outputs Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Outputs Lo | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Error Check (CRC/LRC) | --- | 0x58, 0x85 | "6E" | 0x36, 0x45 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- In case of address 0x1015~0x1000 output bit value: 00000000_00000000 changes to 00000001_01010101.

### 3.3.11. 16 (0x10) Write Multiple Registers

This function code is used to write a block of contiguous registers (1 to approx. 120 registers) in a remote device.
The requested written values are specified in the request data field. Data is packed as two bytes per register.
The normal response returns the function code, starting address, and quantity of registers written.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Starting Address Hi | 0x08 | 0x08 | "08" | 0x30, 0x38 |
| Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Registers Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Registers Lo | 0x01 | 0x01 | "01" | 0x30, 0x31 |
| Byte Count | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Register Value#0 Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Register Value#0 Lo | 0xFF | 0xFF | "FF" | 0x46, 0x46 |
| Error Check (CRC/LRC) | --- | 0xDE, 0xB2 | "83" | 0x38, 0x33 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x10 | 0x10 | "10" | 0x31, 0x30 |
| Starting Address Hi | 0x08 | 0x08 | "08" | 0x30, 0x38 |
| Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Registers Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Registers Lo | 0x01 | 0x01 | "01" | 0x30, 0x31 |
| Error Check (CRC/LRC) | --- | 0x0B, 0xEB | "84" | 0x38, 0x34 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- In case of address 0x0800, 0x0801 output register value: 0x0000, 0x0000 changes to 0x1122, 0x3344.

### 3.3.12. 23 (0x17) Read/Write Multiple Registers

This function code performs a combination of one read operation and one write operation in a single MODBUS transaction. The write operation is performed before the read. The request specifies the starting address and number of holding registers to be read as well as the starting address, number of holding registers, and the data to be written. The byte count specifies the number of bytes to follow in the write data field.
The normal response contains the data from the group of registers that were read. The byte count field specifies the quantity of bytes to follow in the read data field.

- **Request**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x17 | 0x17 | "17" | 0x31, 0x37 |
| Read Starting Address Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Read Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Read Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Read Lo | 0x01 | 0x01 | "01" | 0x30, 0x31 |
| Write Starting Address Hi | 0x08 | 0x08 | "08" | 0x30, 0x38 |
| Write Starting Address Lo | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Write Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Quantity of Write Lo | 0x01 | 0x01 | "01" | 0x30, 0x31 |
| Byte Count | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Write Reg. Value#0 Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Write Reg. Value#0 Lo | 0xFF | 0xFF | "FF" | 0x46, 0x46 |
| Error Check (CRC/LRC) | --- | 0x1B, 0xCC | "7B" | 0x37, 0x42 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0x0A |

- **Response**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x63 | 0x63 | "63" | 0x36, 0x33 |
| Function Code | 0x17 | 0x17 | "17" | 0x31, 0x37 |
| Byte Count | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Read Reg. Value#0 Hi | 0x00 | 0x00 | "00" | 0x30, 0x30 |
| Read Reg. Value#0 Lo | 0xFF | 0xFF | "FF" | 0x46, 0x46 |
| Error Check (CRC/LRC) | --- | 0x04, 0x3C | "85" | 0x38, 0x35 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- In case of address 0x0800, 0x0801 output register value: 0x0000, 0x0000 changes to 0x1122, 0x3344.

### 3.3.13. Error Response

In an exception response, the server sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hexadecimal higher than the value would be for a normal response.

- **Exception Response Example**

| Field name | Example | RTU | ASCII | ASCII (bus line) |
|---|---|---|---|---|
| Start of Frame | --- | t1-t2-t3 | ":" | 0x3A |
| Slave Address | 0x07 | 0x07 | "07" | 0x30, 0x37 |
| Function Code | 0x81 | 0x81 | "81" | 0x38, 0x31 |
| Exception Code | 0x02 | 0x02 | "02" | 0x30, 0x32 |
| Error Check (CRC/LRC) | --- | 0x22, 0xC0 | "76" | 0x37, 0x36 |
| End of Frame | --- | t1-t2-t3 | CR, LF | 0x0D, 0xA |

- **Exception Codes**

| Exception Code | Name | Description |
|---|---|---|
| 01 | Illegal Function | The function code received in the query is not an allowable action for the server (or slave). |
| 02 | Illegal Data Address | The data address received in the query is not an allowable address for the server (or slave). |
| 03 | Illegal Data Value | A value contained in the query data field is not an allowable value for server (or slave). |
| 04 | Slave Device Failure | An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action. |
| 05 | Acknowledge | The server (or slave) has accepted the request and is processing it, but a long duration of time will be required to do so. |
| 06 | Slave Device Busy | Specialized use in conjunction with programming commands.<br>The server (or slave) is engaged in processing a long–duration program command. The client (or master) should retransmit the message later when the server (or slave) is free. |
| 08 | Memory Parity Error | The server (or slave) attempted to read record file, but detected a parity error in the memory. The client (or master) can retry the request, but service may be required on the server (or slave) device. |
| 0A | Gateway Path Unavailable | Specialized use in conjunction with gateways, indicates that the gateway was unable to allocate an internal communication path from the input port to the output port for processing the request. |

- MD9289 response exception code 01, 02, 03, 04 and 06.

## 3.4. MODBUS Special Register Map

The special register map can be accessed by function code 3, 4, 6 and 16. Also the special register map must be accessed by read/write of each address (one address).

### 3.4.1. Adapter Identification Special Register (0x1000, 4096)

| Address | Access | Type, Size | Description |
|---|---|---|---|
| 0x1000(4096) | Read | 1word | Vendor ID = 0x02E5(741), Crevis. Co., Ltd. |
| 0x1001(4097) | Read | 1word | Device type = 0x000C, Network Adapter |
| 0x1002(4098) | Read | 1word | Product Code = 0xA800 |
| 0x1003(4099) | Read | 1word | Firmware revision, if 0x0101, revision 1.01 |
| 0x1004(4100) | Read | 2word | Product unique serial number |
| 0x1005(4101) | Read | String<br>upto 34byte | Product name string (ASCII)<br>“MD9289,Modbus/TCP Adapter,MBUS” |
| 0x1006(4102) | Read | 1word | Sum check of EEPROM |
| 0x1010(4112) | Read | 2word | Firmware release date |
| 0x1011(4113) | Read | 2word | Product manufacturing inspection date |
| 0x101E(4126) | Read | <br>7word<br>- 1word<br>- 1word<br>- 1word<br>- 1word<br>- 1word<br>- 2word<br><br>15word<br>- 2word<br>- 2word<br>- 2word<br>- 3word<br>- 1word<br>- 1word<br>- 1word<br>- 1word<br>- 2word | Composite Id of following address<br>* RTU mode<br>0x1100(4352), Modbus RS232 Node. (Fixed 0x0001)<br>0x1000(4096), Vendor ID<br>0x1001(4097), Device type<br>0x1002(4098), Product code<br>0x1003(4099), Firmware revision<br>0x1004(4100), Product serial number<br><br>*TCP mode<br>0x1050(4176), IP address<br>0x1051(4177), Subnet mask<br>0x1052(4178), Gateway<br>0x1053(4179), Ethernet physical address (MAC ID)<br>0x1000(4096), Vendor ID<br>0x1001(4097), Device type<br>0x1002(4098), Product code<br>0x1003(4099), Firmware revision<br>0x1004(4100), Product serial number |

- String Type consists of valid string length (first 1word) and array of characters

### 3.4.2. Adapter Watchdog Time, other Time Special Register (0x1020, 4128)

A watchdog timer can be configured for timeout periods up to 65535(1unit=100msec). The Watchdog timer will timeout (timer decreased, reached 0) if ModBus operation to the slave node does not occur over the configured watchdog value, then the slave adapter forces that slot output value is automatically set to user-configured fault actions and values.

| Address | Access | Type, Size | Description |
|---|---|---|---|
| 0x1020(4128) | Read/Write | 1word | Watchdog time value 16bit unsigned.<br>The time value is represented by multiples of 100msec.<br>The 0 (watchdog timeout disabled) is default value.<br>A changing of watchdog time value resets watchdog error and counter. |
| 0x1021(4129) | Read | 1word | Watchdog timer remain value<br>This value is decreased every 100msec |
| 0x1022(4130) | Read | 1word | Watchdog error counter, it is cleared by writing address 0x1020 |
| 0x1023(4131) | Read | 1word | Auto recovery Watchdog error when receiving new frame.<br>1:Enable |
| 0x1028(4136) | Read | 1word | IO update time, main loop time. (1usec unit) |

* In case of Watchdog error, monitoring of fault output is not possible.

* In case of Secondary module, when power is turn on data is received from Primary. But this data is not stored in eeprom.

### 3.4.3. Adapter TCP/IP Special Register (0x1040, 4160)

| Address | Access | Type, Size | Description |
|---|---|---|---|
| 0x1040(4160) | Read | 1word | Reserved |
| 0x1041(4161) | Read/Write | 1word | MODBUS/TCP connection timeout time. (0.5sec unit)<br>Maximum time of ModBus connection to stay to be opened without receiving a ModBus request. 0~3600<br>The 120 (60sec) is default value.<br>The value 0 disables connection time out specially. |
| 0x1042(4162) | Read | 1word | Number of ModBus/TCP connected till now |
| 0x1043(4163) | Read | 1word | ModBus/TCP port, fixed 502 |
| 0x1044(4164) | Read | 1word | Ethernet Interface Speed, 10(10Mbps) or 100(100Mbps) |
| 0x1045(4165)* | Read/Write | 1word | IP Setting Method. 0: BOOTP, 1:DHCP |
| 0x1046(4166) | --- | --- | Reserved. |
| 0x1047(4167) | Read | 1word | Status of DHCP/BOOTP(Enable/Disable).<br>0 : OFF, 1 : ON |
| 0x1048(4168) | Read | 1word | Enable/disable Lowest IP address via DIP Switch, 1:Enabled |
| 0x1050(4176) | Read/Write | 2word | IP address. If 192.168.123.1, then 0xA8C0, 0x017B.<br>After update this value, IP address, Subnet mask and Gateway are applied as new one. |
| 0x1051(4177) | Read/Write | 2word | Subnet mask. If 255.255.255.0, then 0xFFFF, 0x00FF. |
| 0x1052(4178) | Read/Write | 2word | Gateway. If 192.168.123.254, then 0xA8C0, 0xFE7B. |
| 0x1053(4179) | Read | 3word | Ethernet physical address (MAC-ID).<br>If 11-22-33-44-55-66, then 0x2211, 0x4433, 0x6655. |

* Power off and then power on, this value is applied.

### 3.4.4. Adapter Hotswap and Redundancy Special Register (0x1060, 4192)

| Address | Access | Type, Size | Description |
|---|---|---|---|
| 0x1060(4192) | Read/Write | 1word | Hot swap status 0 : Enable(default)<br>1 : Disable |
| 0x1062(4194)* | Read | 1word | Error slot detection<br>0 : No error slot<br>1 : Error slot detection |
| 0x1063(4195)* | Read | 4word | Error slot location, 8x8 bit |
| 0x1070 | Read | 1word | Primary : 0<br>Secondary : 1 |
| 0x1071 | Read | 1word | Secondary module status<br>0 : normal operation<br>1 : module error or removed |
| 0x1072 | Read/Write | 1word | If it is set by 1 in Primary, it will be switchover |
| 0x1073** | Read/Write | 1word | - Between Primary and Secondary switchover time (100msec unit)<br>- The default is set to 10.<br>- If the value is set to 0, Communication will not change to secondary. |

* 0x1062 and 0x1063 functions are only available if hot swap(0x1060) is enabled.

** If it set watchdog error, it recommend high value better than 0x1073 register value. In case of Secondary module, when power is turn on data is received from Primary. But this data is not stored in eeprom.

### 3.4.5. Adapter Information Special Register (0x1100, 4352)

| Address | Access | Type, Size | Description |
|---|---|---|---|
| 0x1102(4354) | Read | 1word | Start address of input image word register. =0x0000 |
| 0x1103(4355) | Read | 1word | Start address of output image word register. =0x0800 |
| 0x1104(4356) | Read | 1word | Size of input image word register. |
| 0x1105(4357) | Read | 1word | Size of output image word register. |
| 0x1106(4358) | Read | 1word | Start address of input image bit. = 0x0000 |
| 0x1107(4359) | Read | 1word | Start address of output image bit. =0x1000 |
| 0x1108(4360) | Read | 1word | Size of input image bit. |
| 0x1109(4361) | Read | 1word | Size of output image bit. |
| 0x110A(4362) | Read | 1word | Update time for cyclic data change (same as 0x1028) |
| 0x110E(4366) | Read | upto 33word | Expansion slot's M-number including M<br>First 1word is adapter's number, if MD9289, then 0x9289 |
| 0x1110(4368) | Read | 1word | Number of expansion slot |
| 0x1113(4371) | Read | upto 33word | Expansion slot Module Id. First 1word is adapter's module id. |
| 0x1119(4377) | Read | 1word | Hi byte is ModBus status, low byte is internal status.<br>Zero value means 'no error'. |
| 0x111D(4381) | Read | 1word | Adapter M-Series Revision. |

| ModBus Status | Internal bus status(M-Bus) |
|---|---|
| 0x00 : No Error<br>0x01 : ERR_DIP_SWITCH<br>0x40 : ERR_CRC_LRC<br>0x80 : ERR_Watchdog | 0x01 : INIT_STATE<br>0x02 : IDLE_STATE<br>0x03 : RUN_STATE<br>0x04 : STOP_STATE<br>0x05 : FAULT_STATE<br>0x06 : RESET_STATE<br>0x07 : CRCERR_STATE<br>0x08 : PAUSE_STATE<br>0x80* : At Hot swap mode<br>expansion module error |

* After the system is reset, the new "Set Value" action is applied.

### 3.4.6. Expansion Slot Information Special Resister (0x2000, 8192)

Each expansion slot has 0x20(32) address offset and same information structure.

Slot#1 0x2000(8192)~0x201F(8223)
Slot#2 0x2020(8224)~0x203F(8255)
Slot#3 0x2040(8256)~0x205F(8287)
Slot#4 0x2060(8288)~0x207F(8319)
Slot#5 0x2080(8320)~0x209F(8351)
Slot#6 0x20A0(8352)~0x20BF(8383)
Slot#7 0x20C0(8384)~0x20DF(8415)
Slot#8 0x20E0(8416)~0x20FF(8447)
Slot#9 0x2100(8448)~0x211F(8479)
Slot#10 0x2120(8480)~0x213F(8511)
Slot#11 0x2140(8512)~0x215F(8543)
Slot#12 0x2160(8544)~0x217F(8575)
Slot#13 0x2180(8576)~0x219F(8607)
Slot#14 0x21A0(8608)~0x21BF(8639)
Slot#15 0x21C0(8640)~0x21DF(8671)
Slot#16 0x21E0(8672)~0x21FF(8703)
Slot#17 0x2200(8704)~0x221F(8735)
Slot#18 0x2220(8736)~0x223F(8767)
Slot#19 0x2240(8768)~0x225F(8799)
Slot#20 0x2260(8800)~0x227F(8831)
Slot#21 0x2280(8832)~0x229F(8863)
Slot#22 0x22A0(8864)~0x22BF(8895)
Slot#23 0x22C0(8896)~0x22DF(8927)
Slot#24 0x22E0(8928)~0x22FF(8959)
Slot#25 0x2300(8960)~0x231F(8991)
Slot#26 0x2320(8992)~0x233F(9023)
Slot#27 0x2340(9024)~0x235F(9055)
Slot#28 0x2360(9056)~0x237F(9087)
Slot#29 0x2380(9088)~0x239F(9119)
Slot#30 0x23A0(9120)~0x23BF(9151)
Slot#31 0x23C0(9152)~0x23DF(9183)
Slot#32 0x23E0(9184)~0x23FF(9215)
Slot#33 0x2400(9216)~0x241F(9247)
Slot#34 0x2420(9248)~0x243F(9279)
…..
Slot#63 0x27C0(10176)~0x27DF(10207)

| Address Offset | Expansion Slot#1 | Expansion Slot#2 | Expansion Slot#3 | Expansion Slot#4 | …….. | Expansion Slot#63 |
|---|---|---|---|---|---|---|
| + 0x00(+0) | 0x2000(8192) | 0x2020(8224) | 0x2040(8256) | 0x2060(8288) | ……. | 0x27C0(10176) |
| + 0x01(+1) | 0x2001(8193) | 0x2021(8225) | 0x2041(8257) | 0x2061(8289) | ……. | 0x27C1(10177) |
| + 0x02(+2) | 0x2002(8194) | 0x2022(8226) | 0x2042(8258) | 0x2062(8290) | ……. | 0x27C2(10178) |
| + 0x03(+3) | 0x2003(8195) | 0x2023(8227) | 0x2043(8259) | 0x2063(8291) | ……. | 0x27C3(10179) |
| + 0x04(+4) | 0x2004(8196) | 0x2024(8228) | 0x2044(8260) | 0x2064(8292) | ……. | 0x27C4(10180) |
| + 0x05(+5) | 0x2005(8197) | 0x2025(8229) | 0x2045(8261) | 0x2065(8293) | ……. | 0x27C5(10181) |
| + 0x06(+6) | 0x2006(8198) | 0x2026(8230) | 0x2046(8262) | 0x2066(8294) | ……. | 0x27C6(10182) |
| + 0x07(+7) | 0x2007(8199) | 0x2027(8231) | 0x2047(8263) | 0x2067(8295) | ……. | 0x27C7(10183) |
| + 0x08(+8) | 0x2008(8200) | 0x2028(8232) | 0x2048(8264) | 0x2068(8296) | ……. | 0x27C8(10184) |
| + 0x09(+9) | 0x2009(8201) | 0x2029(8233) | 0x2049(8265) | 0x2069(8297) | ……. | 0x27C9(10185) |
| + 0x0A(+10) | 0x200A(8202) | 0x202A(8234) | 0x204A(8266) | 0x206A(8298) | ……. | 0x27CA(10186) |
| + 0x0B(+11) | 0x200B(8203) | 0x202B(8235) | 0x204B(8267) | 0x206B(8299) | ……. | 0x27CB(10187) |
| + 0x0C(+12) | 0x200C(8204) | 0x202C(8236) | 0x204C(8268) | 0x206C(8300) | ……. | 0x27CC(10188) |
| + 0x0D(+13) | 0x200D(8205) | 0x202D(8237) | 0x204D(8269) | 0x206D(8301) | ……. | 0x27CD(10189) |
| + 0x0E(+14) | 0x200E(8206) | 0x202E(8238) | 0x204E(8270) | 0x206E(8302) | ……. | 0x27CE(10190) |
| + 0x0F(+15) | 0x200F(8207) | 0x202F(8239) | 0x204F(8271) | 0x206F(8303) | ……. | 0x27CF(10191) |
| + 0x10(+16) | 0x2010(8208) | 0x2030(8240) | 0x2050(8272) | 0x2070(8304) | ……. | 0x27D0(10192) |
| + 0x11(+17) | 0x2011(8209) | 0x2031(8241) | 0x2051(8273) | 0x2071(8305) | ……. | 0x27D1(10193) |
| + 0x12(+18) | 0x2012(8210) | 0x2032(8242) | 0x2052(8274) | 0x2072(8306) | ……. | 0x27D2(10194) |
| + 0x13(+19) | 0x2013(8211) | 0x2033(8243) | 0x2053(8275) | 0x2073(8307) | ……. | 0x27D3(10195) |
| + 0x14(+20) | 0x2014(8212) | 0x2034(8244) | 0x2054(8276) | 0x2074(8308) | ……. | 0x27D4(10196) |
| + 0x15(+21) | 0x2015(8213) | 0x2035(8245) | 0x2055(8277) | 0x2075(8309) | ……. | 0x27D5(10197) |
| + 0x16(+22) | 0x2016(8214) | 0x2036(8246) | 0x2056(8278) | 0x2076(8310) | ……. | 0x27D6(10198) |
| + 0x17(+23) | 0x2017(8215) | 0x2037(8247) | 0x2057(8279) | 0x2077(8311) | ……. | 0x27D7(10199) |
| + 0x18(+24) | 0x2018(8216) | 0x2038(8248) | 0x2058(8280) | 0x2078(8312) | ……. | 0x27D8(10200) |
| + 0x19(+25) | 0x2018(8217) | 0x2038(8249) | 0x2058(8281) | 0x2078(8313) | ……. | 0x27D9(10201) |
| + 0x1A(+26) | 0x201A(8218) | 0x203A(8250) | 0x205A(8282) | 0x207A(8314) | ……. | 0x27DA(10202) |
| + 0x1B(+27) | 0x201B(8219) | 0x203B(8251) | 0x205B(8283) | 0x207B(8315) | ……. | 0x27DB(10203) |
| + 0x1C(+28) | 0x201C(8220) | 0x203C(8252) | 0x205C(8284) | 0x207C(8316) | ……. | 0x27DC(10204) |
| + 0x1D(+29) | 0x201D(8221) | 0x203D(8253) | 0x205D(8285) | 0x207D(8317) | ……. | 0x27DD(10205) |
| + 0x1E(+30) | 0x201E(8222) | 0x203E(8254) | 0x205E(8286) | 0x207E(8318) | ……. | 0x27DE(10206) |
| + 0x1F(+31) | 0x201F(8223) | 0x203F(8255) | 0x205F(8287) | 0x207F(8319) | ……. | 0x27DF(10207) |

| Address Offset | Access | Type, Size | Description |
|---|---|---|---|
| + 0x02(+2) ** | Read | 1word | Input start register address of input image word this slot. |
| + 0x03(+3) ** | Read | 1word | Input word's bit offset of input image word this slot. |
| + 0x04(+4) ** | Read | 1word | Output start register address of output image word this slot. |
| + 0x05(+5) ** | Read | 1word | Output word's bit offset of output image word this slot. |
| + 0x06(+6) ** | Read | 1word | Input bit start address of input image bit this slot. |
| + 0x07(+7) ** | Read | 1word | Output bit start address of output image bit this slot. |
| + 0x08(+8) ** | Read | 1word | Size of input bit this slot |
| + 0x09(+9) ** | Read | 1word | Size of output bit this slot |
| + 0x0A(+10)** | Read | n word | Read input data this slot |
| + 0x0B(+11)** | Read/Write | n word | Read/write output data this slot |
| + 0x0E(+14) | Read | 1word | M-number, if M-1238, returns 0x1238 |
| + 0x0F(+15) | Read | String upto 72byte | First 1word is length of valid character string.<br>If M12DF, returns<br>"00 23 4D 31 32 44 46 2C 20 31 36 44 49 2C 20 32 34 56 64 63 2C 20 55 6E 69 76 65 72 73 61 6C 20 31 38 "<br>Valid character size = 0x001E =30 characters,<br>"M12DF, 16DI, 24Vdc, Universal 18RTB" |
| + 0x10(+16) | Read | 1word | Size of configuration parameter byte |
| + 0x11(+17)** | Read/Write | n word | Read/write Configuration parameter data, up to 8byte. |
| + 0x17(+23) | Read | 2word | Firmware Revision<br>ex) 0x00010010 (Major revision 1 /Minor revision 1, Rev 1.001) |
| + 0x19(+25) | Read | 2word | Firmware release date. |

* After the system is reset, the new "Set Value" action is applied.
** Nothing of output, input, memory or configuration parameter corresponding slot returns Exception 02.

## 3.5. Supported MODBUS Function Codes

MODBUS Reference Documents

http://www.modbus.org

MODBUS Tools

http://www.modbustools.com, modbus poll
http://www.win-tech.com, modscan32